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Consultation on Proposed Allocation of 6 GHz Band
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1 Summary of major points

Qualcomm's comments below address the following key points:

- To meet growing needs for broadband capacity, industry must deploy wider channel bandwidths that are, in turn, enabled by opening the 6 GHz band for use by unlicensed devices.
- Qualcomm strongly supports IMDA's proposal to open the lower portion of the 6 GHz band for RLAN/Wi-Fi use.
- Qualcomm also encourages opening the full 6 GHz band, including the 6425-7025/7125 MHz range, for use by unlicensed devices and technologies. This approach will bring benefits including:
 - wider channels and minimization of interference,
 - supporting Singapore's technology leadership position, and
 - enabling more immediate realization of the full benefit of Wi-Fi 6.
- Qualcomm proposes certain modifications to the proposed technical requirements for use of the 6 GHz band.

2 Comments

2.1 Introduction

Qualcomm Incorporated (Qualcomm) welcomes the opportunity to provide input to the Infocomm Media Development Authority (IMDA) consultation paper *Proposed Allocation of 6 GHz Band in Singapore* (the Consultation).

Qualcomm is the world's leading wireless technology innovator and the driving force behind the development, launch, and expansion of 5G. When we connected the phone to the internet, the mobile revolution was born. Today, our foundational technologies enable the mobile ecosystem and are found in every 3G, 4G, and 5G smartphone. We bring the benefits of mobile to new industries, including automotive, the internet of things, and computing, and are leading the way to a world where everything and everyone can communicate and interact seamlessly. From our homes to airports, campuses, and the enterprise, Qualcomm's Wi-Fi solutions build on our world-class engineering capabilities to connect users and devices.

One of our major areas of focus is the development of advanced wireless technologies, including 5G and Wi-Fi-based technologies.

In this response, Qualcomm provides specific answers to the questions posed in the Consultation, as well as additional comments for IMDA's consideration with regard to future work.

2.2 Context

A wide range of settings and use cases increasingly rely on unlicensed or license-exempt spectrum for their broadband needs. As demand has increased, locations including schools, industrial sites, medical

facilities, and transportation hubs have deployed Wi-Fi infrastructure more densely to meet capacity needs. To meet growing needs for broadband capacity the industry must deploy wider channel bandwidths that are, in turn, enabled by opening the full 1200 MHz of the 6 GHz band.

To retain the expected quality of service for users, channels wider than 80 MHz are needed. Without wider channels (e.g., 160 MHz and 320 MHz), there will be a detrimental impact on real-time high-quality voice and video services, and immersive services such as augmented and virtual reality (AR/VR) will be starved of sufficient capacity.

Unlicensed use of the 6 GHz band is key to enabling next-generation Wi-Fi, higher-capacity broadband, and the ongoing development of innovative digital services. Looking ahead to the development of future unlicensed technologies, including Wi-Fi 7, the 6 GHz band will be an important enabler of advanced wireless connectivity. We encourage IMDA to move quickly to enable Singaporean users access to this crucial spectrum resource.

2.3 Proposed allocation of 6 GHz band in Singapore

2.3.1 5925-6425 MHz

Qualcomm strongly supports IMDA's proposal to allocate the lower portion of the 6 GHz band for RLAN/Wi-Fi use. We encourage the expedient replanning of the 5925-6425 MHz range, at a minimum, to accommodate the rapidly growing demand for wireless connectivity driven not only by the COVID-19 pandemic but also by the steady growth in wireless data consumption across multiple device form factors and service offerings. The 6 GHz band can benefit from a regulatory framework similar to that employed in the 5 GHz band to support next-generation Wi-Fi, i.e., IEEE 802.11ax in the 6 GHz band (Wi-Fi 6E) and 802.11be (Wi-Fi 7), as well as 5G NR in unlicensed spectrum (5G NR-U), and future technologies that improve overall system throughput, reliability, and network responsiveness. All of this innovation can be accomplished while protecting incumbent 6 GHz services and planned 5.9 GHz C-V2X services.

Wi-Fi 6 in the 6 GHz band (Wi-Fi 6E) will expand capacity while taking advantage of greenfield spectrum that will not require interoperability with existing 6 GHz Wi-Fi technology, as would be the case if the technology were deployed in the 2.4 GHz or 5 GHz bands. Opening the 6 GHz band would enable significantly improved user experience and spectral efficiency.

Several regulators around the world have already opened access to the 6 GHz band for unlicensed use to allow Wi-Fi 6 and Wi-Fi 6E applications. Notably, countries including Australia, Bahrain, Brazil, Canada, Chile, Colombia, Hong Kong, Japan, Jordan, Kenya, Malaysia, Mexico, Morocco, New Zealand, Qatar, Russia, Saudi Arabia, South Korea, Taiwan, Turkiye, the United Arab Emirates, the United Kingdom, and the United States have allowed license-exempt use of the band. A European decision opening the 6 GHz band for unlicensed use was also adopted, and countries including Belgium, France, Germany, Norway, Sweden, and Switzerland are already implementing it.

2.4 6425-7125 MHz

While IMDA's proposed allocation of the 5925-6425 MHz band is an important and necessary step to enhance Wi-Fi capacity and capability, Qualcomm also encourages opening of the full 6 GHz band, including the 6425-7025/7125 MHz range, for use by unlicensed devices and technologies. The recent proliferation of wireless technologies operating in unlicensed frequencies has significantly increased

demand for this spectrum. Allocating the full band for RLAN use will bring the greatest benefit to Singapore’s users.

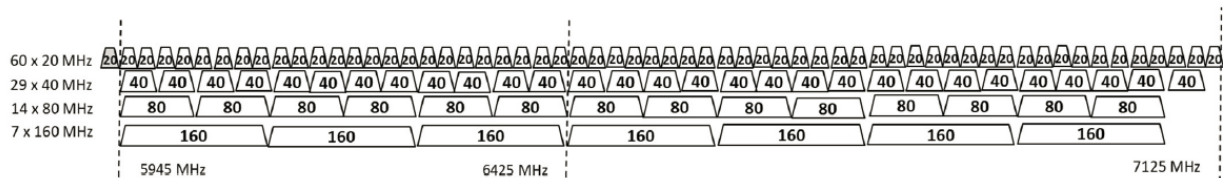
Moreover, we believe rapid allocation of the full band for RLAN use is needed to realize the full economic and societal benefits of new wireless technologies. In this regard, IMDA should move swiftly to make both the lower 500 MHz and the upper 600/700 MHz of the 6 GHz band available for use by unlicensed devices. As noted in the Consultation, Wi-Fi standards for the 6 GHz band are in place and ready for use when the spectrum is made available. Delaying a decision on the upper part of the band would prevent Singapore’s users—both consumers and businesses—from enjoying the full benefit of Wi-Fi technologies that can fully utilize multiple wide channels and their associated advanced technologies.

2.4.1 Leveraging the benefits of the full band

Allocation of the full 1100/1200 MHz of the 6 GHz band is encouraged to enable a seamless experience as users transition between different connectivity mediums, a priority highlighted by IMDA in para. 6 of the Consultation. As further noted in the Consultation, Wi-Fi development needs to keep pace with Singapore’s nationwide broadband network (NBN) developments—including the planned upgrade to 10 Gbps speeds. Wi-Fi 6E will help to deliver that seamless experience, delivering broadband connectivity to end-user devices in homes and offices.

This is further illustrated by considering the possible channelization options shown in Figure 1 below. The additional 1200 MHz of channels provided by Wi-Fi 6E provides a roughly equivalent number of 80 MHz channels in 6 GHz as there are 40 MHz channels in the 5 GHz band.

Figure 1: 6 GHz channelization options



The spatial frequency reuse scheme, in which access points automatically sense available channels and serve their users in different channels from those used by nearby access points, minimizes interference between the service sets, or cells, composed by the access points and their client devices. If only 500 MHz (5925-6425 MHz) are made available, only 3 x 160 MHz channels, in the bottom row of Figure 1, can be used. With only 500 MHz available, users would not be able to take full advantage of the benefits of Wi-Fi 6 in the 6 GHz band, and the brunt of that burden in terms of lesser quality and congestion will fall on users of Wi-Fi in enterprises, schools, transportation hubs, and other public venues.

The additional 600/700 MHz (6425-7025/7125 MHz) allows an additional 4 x 160 MHz channels. This limits the frequency reuse factor to 3 instead of 7, whereas the same channel frequency in a cell will be allocated in other cells with a closer proximity (2 cells separation). If the full 1200 MHz is available, the same channel frequency in a cell will be allocated in other cells beyond a 2-cell separation. The possibility of co-frequency interference is thereby minimized. Furthermore, additional 700 MHz would

increase the number of 320 MHz non-overlapping channels to three from the one that would be available in the lower 500 MHz band.

2.4.2 Digital leadership and global momentum

Singapore's advanced digital infrastructure and connectivity have positioned the country as a regional and global leader in the development of technologies, services, and applications, including ongoing smart city and Internet of Things projects. Continued advancement of connectivity infrastructure—including radiofrequency spectrum—is a prerequisite for maintaining Singapore's leadership position in the digital space. The allocation of the full 6 GHz band would place Singapore among the global leaders in embracing the benefits of Wi-Fi 6E and beyond, ready to leverage the growing ecosystem and provide an attractive environment for investors and innovators in the rapidly evolving digital sector.

According to ABI Research, COVID-19's impact on Wi-Fi infrastructure indicates that existing infrastructure is inadequate. Wireless networks are now facing higher demand with more traffic, and users are finding their existing home Wi-Fi networks, inadequate or incapable of supporting the recent 80% increase in upload traffic. Many users are still using older Wi-Fi equipment with legacy Wi-Fi standards, such as 802.11n (Wi-Fi 4), rather than the latest Wi-Fi 6, which has been specifically designed to deal with better provision in more crowded networks.¹

In considering how to open the 6 GHz band for use by Wi-Fi devices, Qualcomm encourages IMDA to consider the long-term trajectory of Wi-Fi 6 adoption and use. By allocating the full 6 GHz band for unlicensed use, IMDA will encourage the availability and adoption of devices that can leverage wider channel bandwidths and lower reuse factors from the outset. This scenario is preferable to a multi-stage approach in which only the lower portion of the band is available, leading to the initial use of equipment designed to leverage a subset of the band. Even after the full band is potentially opened at a later date, the proliferation of equipment tuned for use in the lower portion of the band would crowd out equipment optimized to use the full 6 GHz band, slowing the implementation of Wi-Fi 6's full suite of advancements.

Momentum behind the use of the entire 6 GHz band continues to build on a global basis. Countries including Brazil, Canada, Costa Rica, the Dominican Republic, Guatemala, Honduras, Peru, South Korea, Saudi Arabia, and the United States have opened the entire 5925-7125 MHz range for unlicensed use, and many others are also considering.

By opening the full 1100/1200 MHz of the 6 GHz band, IMDA would make additional spectrum available for current Wi-Fi technologies as well as immediately enable Singaporeans to benefit from the advanced capabilities included in Wi-Fi 6E.

2.5 Technical requirements

Qualcomm supports allocating the 5925-6425 MHz range, and the full 6 GHz band, for both RLAN low power indoor (LPI) and very low power (VLP) use. We note that IMDA has proposed the same power limits as have been adopted by the European Conference of Postal and Telecommunications Administrations (CEPT).

¹ <https://www.broadbandtechreport.com/wireless/article/14174610/abi-demand-spikes-suggest-need-for-fasterwifi>.

2.5.1 Narrowband Operations

Considering IMDA's inclination to align with European standards, it is important for IMDA to require an adequate spectrum-sharing mechanism in order to ensure efficient and fair use of 6 GHz spectrum. This condition is included in comparable regulatory frameworks at the international level. For example, in Europe, ECC Decision 20(01) states that "An adequate spectrum sharing mechanism shall be implemented."²

The ETSI standard EN 303 687 specifies the specific requirements for narrowband frequency-hopping systems to satisfy the spectrum sharing mandate. EN 303 687 defines the mechanism to be "listen before talk (LBT) with a 20 MHz clear channel assessment (CCA)." Qualcomm suggests that IMDA establish appropriate spectrum access mechanisms that will ensure coexistence and fair spectrum sharing between different license-exempt technologies in the 5925-6425 MHz band.

In addition, IMDA should require utilization of a frequency hopping mechanism with at least a minimum number of 15 hop channels for narrowband VLP systems to operate at the higher 10 dB/MHz PSD limit. ECC Decision 20(01) states that "Narrowband devices also require a frequency hopping mechanism based on at least 15 hop channels to operate at a PSD value above 1 dBm/MHz."

2.5.2 Protection of ITS Systems Below 5925 MHz

Although not directly addressed in the Consultation, Qualcomm would like to take this opportunity to address the protection of C-V2X systems that operate in the adjacent band to the 5925 – 6425 MHz. For LPI devices, Qualcomm recommends that IMDA adopt -27 dBm/MHz measured in root mean square (RMS) as out-of-band emission limit. For VLP devices, Qualcomm recommends that IMDA adopt measures that an industry coalition comprised of Broadcom, Cisco Systems, Intel, Meta Platforms, and Qualcomm has proposed for adoption in the United States, Canada, and Brazil:³

1. VLP devices shall comply with an out-of-band emissions level of -37 dBm/MHz measured by root mean square (RMS) at 5925 MHz.
2. VLP devices shall prioritize unlicensed operations in channels above 6000 MHz before beginning operation below 6000 MHz. Manufacturers should be required to submit with their application for equipment authorization a declaration that the equipment complies with this prioritization rule.

The requirement for VLP devices to prioritize unlicensed operations in channels above 6000 MHz will reduce the likelihood of VLP traffic in the channel adjacent to the 5.9 GHz ITS band when VLP devices operate in vehicles. In the incidences when VLP traffic occurs in the channel adjacent to ITS, the out-of-band emissions limit of -37 dBm/MHz RMS should further help to ensure coexistence. VLP devices and ITS (C-V2X) services are expected to operate in close proximity; both may be operating in the same vehicle and alongside other vehicles in slow- and fast-moving traffic schemes, so for VLP devices an

² ECC Decision 20(01), On the harmonised use of the frequency band 5945-6425 MHz for Wireless Access Systems including Radio Local Area Networks (WAS/RLAN) (November 20, 2020).

³ Broadcom, Cisco, Facebook (now Meta Platforms), Intel, and Qualcomm March 1, 2021 Letter to FCC in ET Docket No. 18-295 available at <https://ecfsapi.fcc.gov/file/10301179588420/OOBE-limit-Compr%20Letter%203%201%202021.pdf>

OBE limit of -37 dBm/MHz (RMS) at 5925 MHz is required as well as the prioritization of operations measure set out above to ensure coexistence.

3 Conclusion

Qualcomm is encouraged by IMDA's intent to enable widespread use of the 6 GHz band to enable all stakeholders to plan for successful wireless technology deployments that deliver enhanced and innovative services to users in Singapore. We therefore strongly support IMDA's intent to allocate the lower portion of the 6 GHz band for license-exempt use as proposed in the Consultation. In addition, Qualcomm encourages consideration of an approach that maximizes the benefits of the 6 GHz band through access to the full 5925-7025/7125 MHz range and the incorporation of selected modifications to the proposed technical requirements to maximize harmonization with global and regional developments.

We appreciate the opportunity to provide feedback to IMDA and would be happy to provide further information that could assist in the development and implementation.
